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Performance of New and Old Short-Seasoned *Arachis Hypogea* (Groundnut) Varieties Under Same Agronomic Practices

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Abstract

Performance of three newly released short-seasoned (Nsinjiro, Chitala and JL11) were evaluated against old (Nyanda, Illanda and Tern) groundnuts varieties under same agronomic practices. A field experiment laid in a randomized complete block design (RCBD) with three replicates was done. Varieties were evaluated for days to 50% emergence, 50% flowering, days to physiological maturity, pod and seed yield, and shelling percentage. There were no significant difference in the days to 50% emergence among all varieties but significant difference ($p < 0.05$) were observed on days to 50% flowering. JL11 and Tern took shortest (90 days) and longest (120 days) time to physiological maturity respectively. Chitala had highest (3.804t/ha) and Tern had lowest (3.020t/ha) seed yield. Jl11 had highest (83%) and Nyanda least (68%) shelling percentage. Results showed that the new varieties out-performed the old varieties in all measured parameters. Therefore, resource constrained farmers may safely opt for the new short-seasoned varieties over the old ones.

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Introduction

Groundnut (*Arachis hypogea)* is a self-pollinating annual legume that originated from South America in Bolivia [1]. It is divided into two subspecies which are *Arachis hypogea* subspecies *hypogea* and *Arachis hypogea* subspecies *fastigiata* [2]. The subspecies *hypogea* are long season, they reach physiological maturity in 120-150 days and subspecies *fastigiata* are the short season varieties which reach physiological maturity in 90-120 days. Groundnut is an economically important crop in subsistence farming [3].

Arachis hypogea plays a significant role in the diet of people providing proteins, carbohydrates and mineral elements [4]. It can be consumed raw or roasted as snacks or ground into peanut butter which can be used as a spread on bread. In addition groundnut is an important oil crop, with uses in industrial oil extraction as well as soap making. The green plant stalk, haulms and shells make a good livestock feed [1]. Being a leguminous crop, groundnuts can fix atmospheric nitrogen into available nitrogen for plant uptake in the soil, hence can be integrated in many cropping systems in the tropics [5]. Above all, groundnut is an important cash crop that can be sold as shelled or unshelled to generate income, thereby improving the farmer's income [3].

Highest groundnut producers in the world are China, India, USA and Nigeria [6] with Nigeria being the highest producer in Africa with an average yield of 1.720 t/ha [7]. In Zimbabwe, groundnut is second after maize in terms of area coverage [6] mainly grown in natural regions II and III under rain fed conditions and little in natural region IV [8]. The Zimbabwean groundnut yields are very low (fluctuating between 0.4 t/ha – 0.6 t/ha since 2008) compared to other groundnut producing countries thereby negatively affecting food security [7].

About 75% of groundnut in Zimbabwe is produced by small holder farmers, with women dominating. Making the crop important in the Zimbabwean economy through income generation and livelihoods improvements. The groundnuts production still remains low in Zimbabwe with an average of <0.5t/ ha due to a number of challenges faced by farmers [6]. Production constraints include poor seed quality, few improved varieties adapted to changing climates, recurring droughts, weeds, low soil fertility and high disease incidences such as early and late leaf spot causing leaf discolouration [4]. According to [5], weeds reduce yield through competition with the crop in the early vegetative stage for soil nutrients, water and light.

Most groundnut varieties currently grown in Zimbabwe were released in more than a decade ago [7] hence no longer adapted to the changing climatic conditions thereby low yield. The old varieties are susceptible to genetic erosion, so compromising their performance resulting to low yields. The groundnuts seed industry is still lagging behind other crops e.g groundnuts varieties are not yet diverse as for maize in Zimbabwe. Small holder farmers who are the major producers, rely on unimproved local landraces, retained seed risking disease carry-over resulting to low yields [8].

In a way to increase availability of improved groundnut varieties to farmers, the Crop Breeding Institute (CBI), Zimbabwe had released three new short seasoned varieties (Nsinjiro, Chitala and JL11). However, besides the pre-release agronomic evaluations, there was need to evaluate the varietal performance under resource poor farmer's management practices. Therefore, the objective of this study was to assess the agronomic performance of the new short season groundnut varieties against old (check) varieties (Nyanda, Illanda and Tern) under mimicked small holder farmer's management conditions.

Materials and Methods

Study Site

The study was carried out at the Department of Research and Specialist Services (DR&SS) in Harare. The DR&SS is in natural region IIa, it receives an average rainfall of 750-1000 mm per annum and an average temperature of 16^{o}C in winter and 26^{o}C in the summer season. DR&SS is located at an altitude of 1506 m above sea level, longitude of 31$^{'o}$03'E and 17048'S latitude. It is characterised by red loamy soils which some crusting tendencies when dry.

Experimental Design

The trial was laid in a Randomised Complete Block Design (RCBD) with three replicates with slope as

the blocking factor. The experiment had six treatments which were the three new short season groundnut varieties which are Chitala, Nsinjiro, JL11 and three check cultivars (Nyanda, Illanda and Tern). The trial was run for three growing seasons from 2014/15 to 2016/17. This was a rainfed experiment and no irrigation was done. However, rainfall was not evenly distributed throughout the growing seasons as it was characterised by moderate to severe mid-season droughts in all three seasons.

Agronomic Practices

Land was disc ploughed using a tractor drawn disc plough with a disc harrow to establish fine tilth. Each plot measured 6 m × 2.25 m. A 0.50 m pathway was left between plots and 1.0 m between blocks. Planting was done at a seed rate of 100kg/ha with an inter-row spacing of 45 cm and in-row spacing of 7.5 cm. Compound D (N 7%: P_2O_5 14%: K_2O 7%) was applied in rows at planting at a rate of 150 kg/ha. At flowering stage calcium sulphate (gypsum) was split applied, 100 kg/ha was applied at day 33 after sowing and another 100 kg/ha applied at day 47 after sowing.

Once off hoe weeding was done at day 15 after planting, this was to mimic the small holder farmers' weed management regime. Usually the small holder farmers weed their fields once and sometimes no weeding at all due to labour constrains [6]. Harvesting was manually done by pulling the groundnuts from the soil.

Data Collection

Days to 50% Emergence

The groundnut seedling start by cracking the soil before fully emerging. Constant checks for emergence of the seedlings were done in the morning and late afternoon. Days to 50% emergence were recorded as the period (days) from sowing to when 50% of the plants had emerged.

Days to 50% Flowering

Days to 50% flowering was recorded as the period (days) from sowing to when 50% of the plants had at least one flower each.

Days to Physiological Maturity

Days to physiological maturity was the period (days) from sowing to when the groundnuts were showing physiological maturity signs. Observation for maturity started when the plants stopped flowering and leaf shedding was pronounced. Briefly, five plants were selected randomly from the discard row and pulled out and pods inspected. When the pods had reached normal size with characteristic veins, the plant were considered to have reached physiological maturity. After determining pod size and colour, the pod was break open to examine the internal seed coat colour and seed colour. When the internal pod had turned to a darker colour and seed turned into the characteristic seed colour to the variety the crop was considered to have reached physiological maturity. The date was then recorded as the day to physiological maturity.

Pod Yield (t/ha)

Plants from each plot were harvested and sun dried. After sun drying the pods were plucked from the plants and weighed (t/ha) before shelling.

Pod yield (t/ha)

Pod yield was calculated using the formula:

Pod yield = pod weight / area harvested × 10 000 .....(1)

Seed Yield (t/ha)

The pods from each plot were unshelled manually and seed yield calculated using the formula:

Seed yield = seed weight (kg) / area harvested × 10 000 .....(2)

Shelling Percentage

Shelling percentage **=** weight of shelled seed / total pod weight × 10 000 ....(3)

Data Analysis

Since all the data were counts, log transformation was done before analysis. Analysis of variance (ANOVA) was done to determine performance of the new short seasoned against old varieties using Genstat 18th edition. The $LSD_{0.05}$ was used to separate means where there were significant ($P<0.05$) differences.

Results and Discussion

There was no significant difference ($P>0.05$) in the days to emergence between the new short seasoned

varieties and the check cultivars (Table 1). However, the days to 50% flowering were significantly different ($p<0.05$) among the varieties (Table 1). The JL11 had the shortest days to 50% flowering and Illanda had the longest days to 50% flowering (Table 1).

There was a significant difference ($p<0.05$) in the days to physiological maturity among the six groundnut varieties. JL11 had the shortest (90.67) time to physiological maturity. Tern took 120 days to reach physiological maturity (Table 1).

Days to 50% Emergence

There was no significant difference in the days to 50% emergence between the new and check seasoned varieties (Table 1). Generally, the varieties emerged on day 7 and 9 which tallies to [9], who reported that groundnut seed takes 8-10 days to emerge after sowing in red loamy soils. The uniform emergence could be as a result of the fine tilth which loosens the soil and allowed the seedling to exert less force to push the soil above [10]. Similarly, [3] asserted that well prepared land allows good drainage which prevents water logging which prevents seed rotting in the soil, thus increasing the chances of seed emergence.

Days to 50% Flowering

There was a significant difference ($p<0.05$) between the new and check varieties on the days to 50% flowering (Table 1). The variations in days to flowering among the groundnut varieties could be attributed to the genotypic difference of the varieties [4]. Nsinjiro, Chitala and JL11 may have been bred to flower earlier than the check cultivars Nyanda, Illanda and Tern. Time to flowering in groundnuts determines the maturity days of the cultivar [11]. [12] reported that, early flowering varieties take fewer days to reach physiological maturity. Early maturity is a desirable characteristic in groundnuts because it enables the crop to escape end of season stress such as droughts and aflatoxin contamination.

Days to Physiological Maturity

Days to physiological maturity significantly ($P<0.05$) varied among the varieties (Table 1). JL11 and Tern took shortest (90.67 days) and longest (120 days) days to reach physiological maturity respectively (Table 1). Earlier study by [4] revealed that variations in days to physiological maturity could be as a result of genotypic differences. The genotypic differences among the short seasoned groundnut varieties could have resulted observed under tested agronomic practices. In general, the new varieties showed very early maturity characteristics as compared to the check varieties.

Average Pod Yield (t/ha) of the Groundnuts Varieties for the three Growing Seasons

Pod yield significantly ($p<0.05$) varied among the short season varieties. The check varieties (Nyanda, Illanda and Tern) had significantly ($P<0.05$) lower pod yield than the new varieties (Figure 1).

Pod yield differed significantly ($p<0.05$) between the new and the check varieties (Figure 1). The outstanding variety was Chitala with pod yield of 4.635 t/ha. Tern was the least performing was Tern with a pod yield of 3.020 t/ha (Figure 1). Variations in yield could have been attributed to genotypic differences of the varieties [10]. The high pod yield in Chitala could suggest that the variety has genotype traits for higher number of pods as compared to other varieties. High pod number is correlated with high pod yield as revealed by [13]. High pod number could be also be as a result of the ability of the Chitala to turn many flowers into pegs which develop into pods. [14] reported that high yielding variety produce more pegs, thus high conversion of pegs into mature pods.

Shelling Percentage

There were significant difference ($p<0.05$) in shelling percentage among the varieties (Figure 2). The JL11 had the highest (87%) while Nyanda had lowest (68%) shelling percentage (Figure 2).

The shelling percentage differed significantly ($p<0.05$) between the new and the check varieties. Generally, the new (Nsinjiro, Chitala and JL11) had higher shelling percentage as compared to Nyanda, Illanda and Tern (Figure 2).

The variations in shelling percentage could be attributed to genotypic differences among the varieties as reported by [4]. The high shelling percentage in the new varieties could also be attributed to the high seed yield. The new varieties showed better dry-biomass portioning than the old varieties with more assimilates channelled to the seed hence maximised seed

Table 1. The mean days to 50% emergency, 50% flowering and physiological maturity for the groundnuts varieties in the three growing seasons.

	Measured parameter		
Variety	Days to 50% emergency	Days to 50% flowering	Days to physiological maturity
Nyanda	8.33	34.33	113.67
Illanda	9.01	36.67	99.33
Tern	8.33	35.67	120.67
Nsinjiro	9.00	34.67	91.33
Chitala	7.99	34.33	91.67
JL11	8.34	33.33	90.67
$LSD_{0.05}$	**1.6**	**0.8**	**0.9**

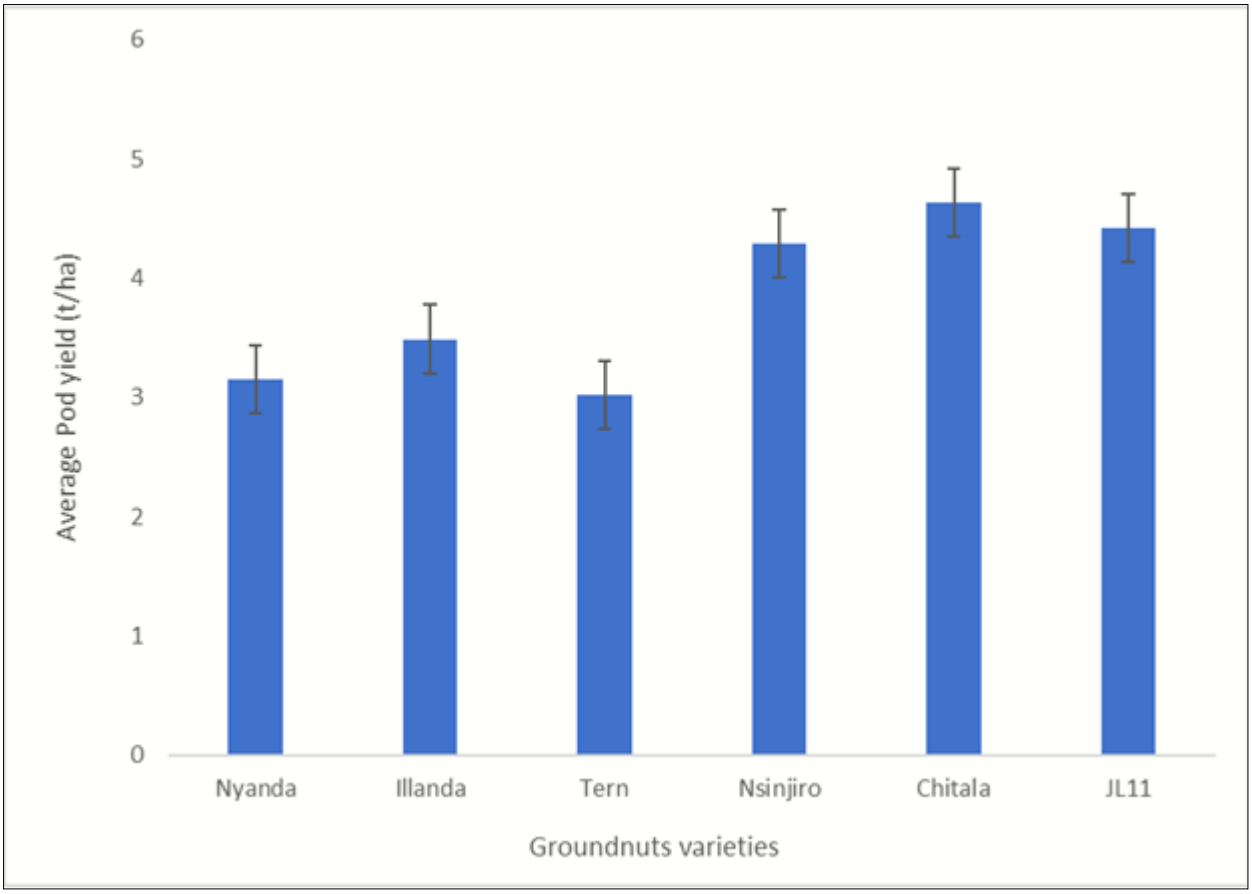

Figure 1. Average pod yield (t/ha) of the groundnuts varieties at physiologically mature stage.

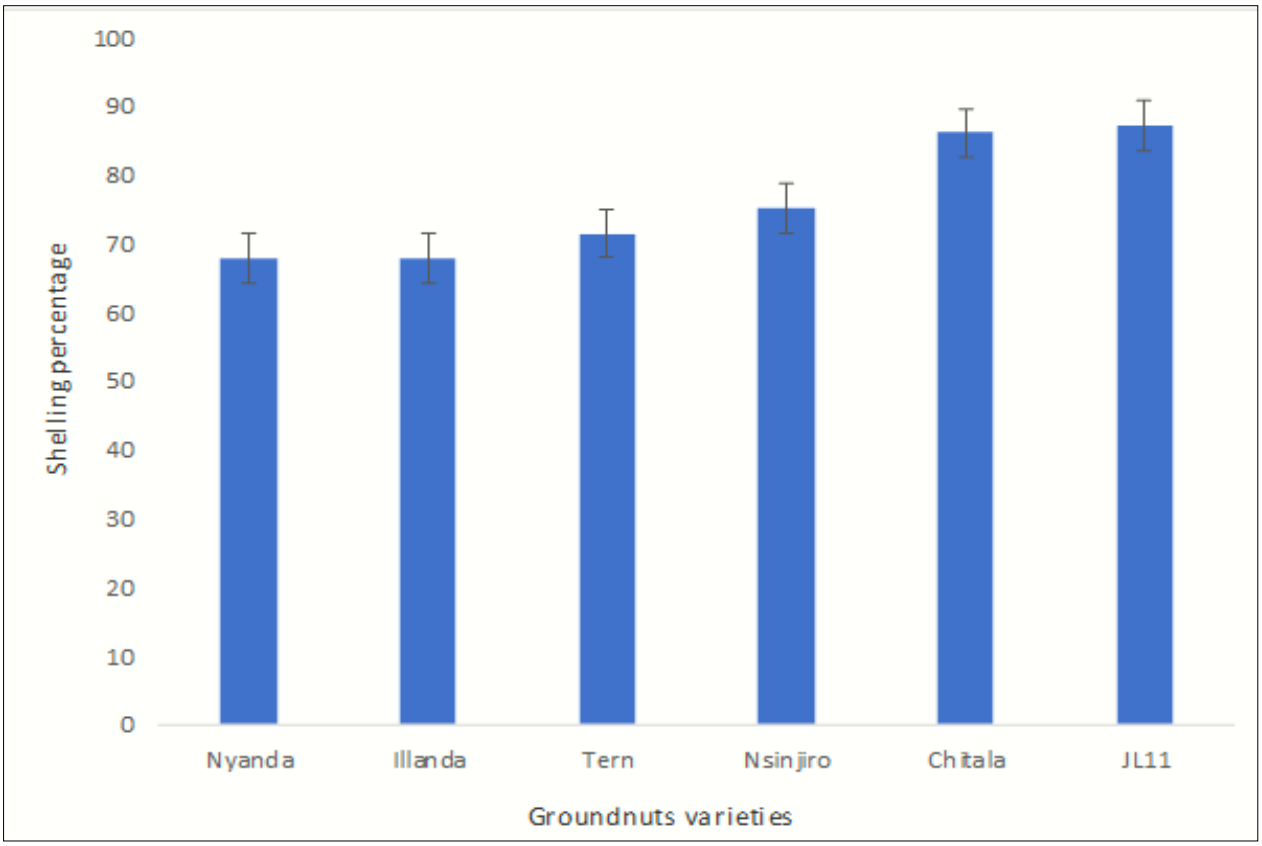

Figure 2. Shelling percentage of the different groundnuts varieties at maturity stage

development. The early flowering and pod establishment in the new varieties gave a seed yield advantage which contributes to the high shelling percentage [9]. Shelling percentage is negatively affected by moisture stress during seed development.

Seed Yield

There were significant seed yield difference ($P<0.05$) among the six short season varieties (Figure 3). The Nsinjiro, Chitala and Jl11 had higher seed yield compared to Nyanda, Illanda and Tern (Figure 3).

The higher yield in the new short season than old varieties could be due to that the new varieties are very early flowering of the varieties. Yield is as a result of partitioning of assimilates during the reproductive stages as stated by [10]. Assimilates produced after flowering are channelled to pod and seed development and this was enhanced by the earliness in the new varieties. The new varieties could have channelled the biomass to the seed before end season droughts hence normal pod filling. Thus the varieties which had early flowering had an earlier advantage to channel assimilates to pod and seed development. This agree to previous study by [15]. Early peg initiation and onset of rapid pod growth results to high yield especially in areas with low rainfall.

The low yield of check varieties may have been as a result of drought stress during the flowering phase of production. [16] revealed that heat stress reduced pod yield in groundnuts by more than 70%. The heat stress causes a delay in flowering, the plants could have suffered moisture stress which progressively inhibit pod and yield due to insufficient plant turgor and lack of assimilates. [17] also reported that heat stress during pod development reduces pod expansion. The check varieties showed less tolerance to drought and heat stress thereby produced few pods and less pod filling.

Conclusion and Recommendations

The new varieties had shorter days to flowering and physiological maturity as compared to the check varieties thereby avoided drought stress. Suggest that the new short-season varieties escaped drought stress as well as heat stress during prolonged mid-season

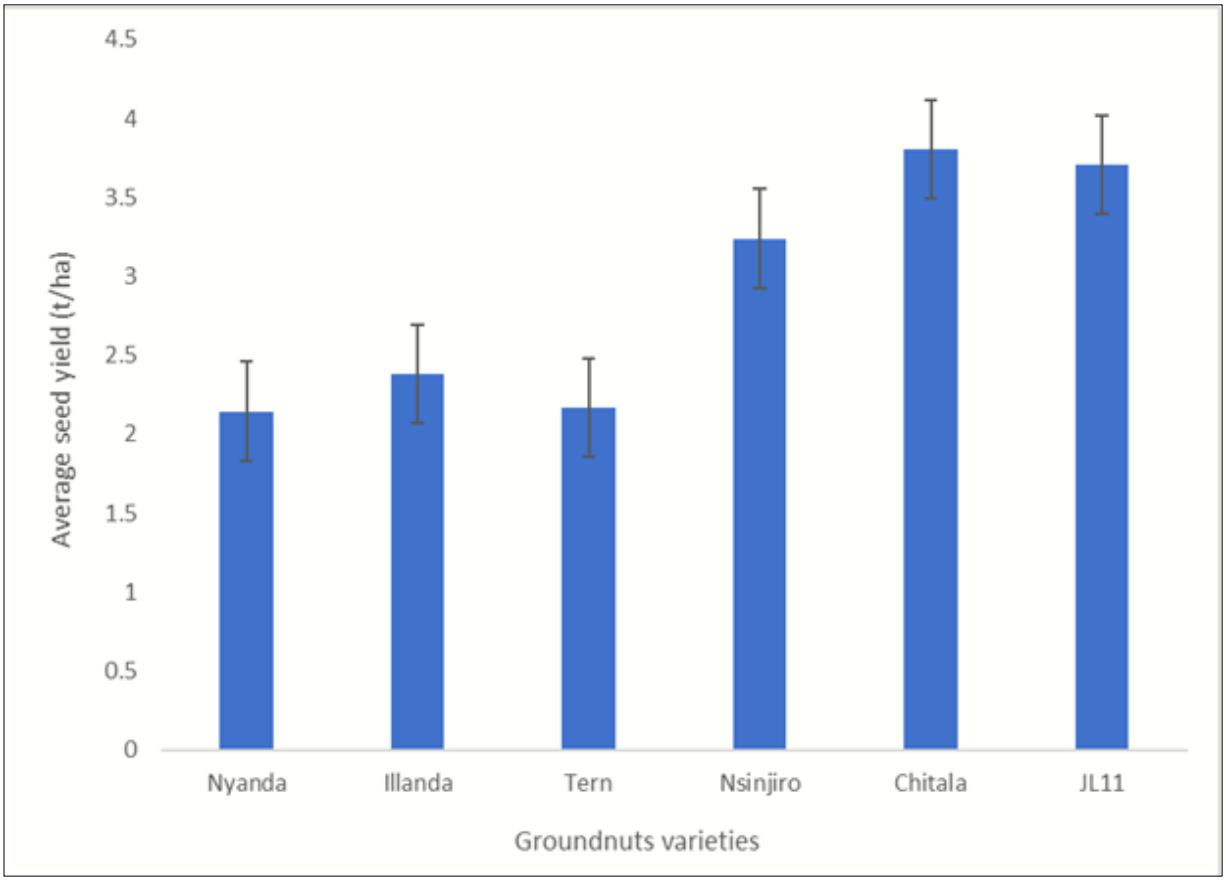

Figure 3. Average seed yield (t/ha) among the groundnuts varieties at physiological maturity stage

droughts. In areas that experience prolonged mid-season drought, farmers can grow the new short season varieties Nsinjiro, Chitala and JL11. The correlation between the varieties may need to be looked at in future research presenting a thorough analysis of co-variance as the newly varieties have genetic basis. It may be worthwhile also to examine how far the results of the experiment at the research center are transferable to farmers' field conditions.

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